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4. TITLE AND SUBTITLE A WORKSHOP ON THE INTERGRATION OF NUMERICAL AND SYMBOLIC COMPUTING MODELS, SARATOGA SPRINGS, NEW YORK			5. FUNDING NUMBERS AFOSR-ISSA-90-0052 61102F 2304/A2	
6. AUTHOR(S) DEEPAK KAPUR			DTIC ELECTE JUL 11 1991 C D AFOSR-TR-91 0558	
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13. ABSTRACT (Maximum 200 words) A workshop on the integration of symbolic and numerical computing methods was held on July 9 to 11, 1990 in Saratoga Springs, New York. The workshop was supported by a grant from the Air Force Office of Scientific Research and the National Science Foundation along with partial funding from G.E. Corporate Research and Development, and the State university of New York at Albany. The workshop was hosted by the Institute for Programming and Logics, the State Univeristy of New York at Albany. Twenty five research papers on symbolic methods, numerical methods, interface between symbolic and numerical methods, applications of symbolics methods in machine vision, robotics, computer aided design, computational geometry, and related topics were presented. Over forty researchers and students participated in the workshop.				
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FINAL PROJECT REPORT

PART I - PROJECT IDENTIFICATION INFORMATION		
1. Program Official/Org.	S. Kamal Abdali - CCR	
2. Program Name	NUMERIC AND SYMBOLIC COMPUTATION PROGRAM	
3. Award Dates (MM/YY)	From: 05/90	To: 04/91
4. Institution and Address	SUNY Albany P.O. Box 9, Albany NY 12201	
5. Award Number	9015424	
6. Project Title	A workshop on the Integration of Numerical and Symbolic Computing Models, Saratoga Springs, New York, July, 1990.	

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NSF Grant Conditions (Article 17, GC-1, and Article 9, FDP-II) require submission of a Final Project Report (NSF Form 98A) to the NSF program officer no later than 90 days after the expiration of the award. Final Project Reports for expired awards must be received before new awards can be made (NSF Grants Policy Manual Section 677).

Below, or on a separate page, provide a summary of the completed projects and technical information and attach it to this form. Be sure to include your name and award number on each separate page. See below for more instructions.

PART II - SUMMARY OF COMPLETED PROJECT (for public use)

The summary (about 200 words) must be self-contained and intellegible to a scientifically literate reader. Without restating the project title, it should begin with a topic sentence stating the project's major thesis. The summary should include, if pertinent to the project being described, the following items:

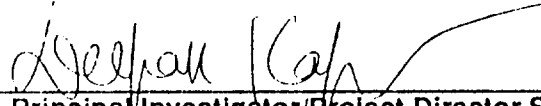
- The primary objectives and scope of the project
- The techniques or approaches used only to the degree necessary for comprehension
- The findings and implications stated as concisely and informatively as possible

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	5/9/91
Principal Investigator/Project Director Signature	Date

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Final Project Report

Title of the Project: A Workshop on the Integration of Numerical and Symbolic Computing Methods

Principal Investigators: Bruce Donald, Deepak Kapur and Joseph Mundy.

Award Number: CCR 9013424

Summary of Results

A workshop on the integration of symbolic and numerical computing methods was held on July 9 to 11, 1990 in Saratoga Springs, New York. The workshop was supported by a grant from the Air Force Office of Scientific Research and the National Science Foundation along with partial funding from G.E. Corporate Research and Development, and the State University of New York at Albany. The workshop was hosted by the Institute for Programming and Logics, the State University of New York at Albany.

Twenty five research papers on symbolic methods, numerical methods, interface between symbolic and numerical methods, applications of symbolics methods in machine vision, robotics, computer aided design, computational geometry, and related topics were presented. Over forty researchers and students participated in the workshop.

The workshop was a major success in establishing a dialogue among researchers in symbolic methods and numerical computation, and their applications in certain disciplines of artificial intelligence. For instances, there was considerable interest and discussion on the continuation method and related homotopy techniques following Morgan's talk. Hopcroft outlined an approach for integrating numerical and symbolic methods by making a clear distinction between logical and numerical decisions, and ensuring consistency among logical decisions by theorem proving techniques.

Participants were highly impressed with the quality of presentations. Given the informal nature of the workshop environment, there was considerable discussion among the participants during the presentations as well as

outside the presentations in informal gatherings. There was a general consensus that significant effort is needed to develop/orient systems providing both symbolic methods and numerical algorithms with a decent interface that facilitates switching back and forth among symbolic and numerical techniques.

Papers presented at the workshop will be published as an edited book. The papers are currently under peer review. A copy of the book will be provided to the NSF and AFOSR when it comes out.

We will be happy to provide copies of each of the papers presented at the workshop.

List of Participants and Papers Presented

- B. Engquist - Recent Developments in Integrating Symbolic and Numerical Methods in Scientific Computing
- A. Morgan - Polynomial Continuation and its Relationship to the Symbolic Reduction of Polynomial Systems
- R. Loos - On the Numerical Computation of Semi Algebraic Sets from Defining Formulas
- J. Hopcroft - Towards Consistent and Robust Geometrical Computation
- H. Sakurai - Automating Machining Planning
- K. Murota - An Algebraic Model for Combinatorial/Structural Analysis of Dynamical Systems
- T. Lozano-Perez - Bitwise Computation of Configuration Space Properties
- K. Kanatani - Computational Projective Geometry
- S. Abhyankar - Review of Algebraic Invariant Theory
- D. Forsyth - Applications of Invariant Theory in Computer Vision
- G. Taubin - Recognition and Positioning of 3D Piecewise Algebraic Objects Using Cartesian Invariants
- D. Huttenlocher - Metrics for Comparing Shapes in the Plane
- J. Canny - Elimination Theory and Motion Planning
- J. Ponce - Use of Elimination Theory in Vision
- B. Roth - Solving Sets of Multivariate Polynomials which Arise in Kinematics
- J-L. Lassez - Reasoning with Linear Constraints

- J. Renegar - Homotopy Methods
- J. Davenport - Symbolic Computation and the Symbolic-Numeric Interface
- P. Milne - A Geometric Algebra System and One of its Algorithms: the N-Dimensional Sturm Sequence
- S. Steinberg - Basic Requirements for the Automatic Generation of Fortran Code
- E. Houstis - RRL ELLPACK
- J. Flaherty - Parallel Computation Methods for Partial Differential Equations
- R. Zippel - Solving PDE's with Symbolic Algebra
- B. Donald - Motion of Compliantly Connected Rigid Bodies
- C. Coelho - A Fast and Precise Method to Extract Vanishing Points

A Workshop on
The Integration Of Numerical and Symbolic
Computing Methods
July 8-11, 1990
Ramada Renaissance Hotel, Saratoga Springs, New York

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